NORTH ATLANTIC TREATY ORGANISATION

RESEARCH AND TECHNOLOGY ORGANISATION

AC/323(SCI-195)TP/220

www.rto.nato.int

RTO EDUCATIONAL NOTES **EN-SCI-195**

Advanced Autonomous Formation Control and Trajectory Management Techniques for Multiple Micro UAV Applications

(Contrôle d'une formation autonome évoluée, et gestion des trajectoires. Techniques d'applications pour micro UAV multiples)

The material in this publication was assembled to support a Lecture Series under the sponsorship of the Systems Concepts and Integration Panel (SCI) presented in Glasgow, United Kingdom, on 19-20 May 2008; in Pamplona, Spain, on 22-23 May 2008 and in Cleveland, Ohio, USA, on 5-6 June 2008.

Published June 2008

The Research and Technology Organisation (RTO) of NATO

RTO is the single focus in NATO for Defence Research and Technology activities. Its mission is to conduct and promote co-operative research and information exchange. The objective is to support the development and effective use of national defence research and technology and to meet the military needs of the Alliance, to maintain a technological lead, and to provide advice to NATO and national decision makers. The RTO performs its mission with the support of an extensive network of national experts. It also ensures effective co-ordination with other NATO bodies involved in R&T activities.

RTO reports both to the Military Committee of NATO and to the Conference of National Armament Directors. It comprises a Research and Technology Board (RTB) as the highest level of national representation and the Research and Technology Agency (RTA), a dedicated staff with its headquarters in Neuilly, near Paris, France. In order to facilitate contacts with the military users and other NATO activities, a small part of the RTA staff is located in NATO Headquarters in Brussels. The Brussels staff also co-ordinates RTO's co-operation with nations in Middle and Eastern Europe, to which RTO attaches particular importance especially as working together in the field of research is one of the more promising areas of co-operation.

The total spectrum of R&T activities is covered by the following 7 bodies:

- AVT Applied Vehicle Technology Panel
- HFM Human Factors and Medicine Panel
- IST Information Systems Technology Panel
- NMSG NATO Modelling and Simulation Group
- SAS System Analysis and Studies Panel
- SCI Systems Concepts and Integration Panel
- SET Sensors and Electronics Technology Panel

These bodies are made up of national representatives as well as generally recognised 'world class' scientists. They also provide a communication link to military users and other NATO bodies. RTO's scientific and technological work is carried out by Technical Teams, created for specific activities and with a specific duration. Such Technical Teams can organise workshops, symposia, field trials, lecture series and training courses. An important function of these Technical Teams is to ensure the continuity of the expert networks.

RTO builds upon earlier co-operation in defence research and technology as set-up under the Advisory Group for Aerospace Research and Development (AGARD) and the Defence Research Group (DRG). AGARD and the DRG share common roots in that they were both established at the initiative of Dr Theodore von Kármán, a leading aerospace scientist, who early on recognised the importance of scientific support for the Allied Armed Forces. RTO is capitalising on these common roots in order to provide the Alliance and the NATO nations with a strong scientific and technological basis that will guarantee a solid base for the future.

Published June 2008

ISBN 978-92-837-0064-7

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
01-06-2008		

4. TITLE AND SUBTITLE

Advanced Autonomous Formation Control and Trajectory Management Techniques for Multiple Micro UAV Applications
(Contrôle d'une formation autonome évoluée, et gestion des trajectoires. Techniques d'applications pour micro UAV multiples)

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

NATO

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

RTO-EN-SCI-195

12. DISTRIBUTION / AVAILABILITY STATEMENT

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

Supporting documents are attached to the report as separate files (PDF, HTM).

14. ABSTRACT

Since the late 1990's, has developed, amongst many of the NATO countries, a strong interest in developing Micro Unmanned Air Vehicles (UAV's) in enhancing the situation awareness on the battlefield in order to improve the accuracy of weapons targeting, and to aid war fighters in the pursuit of tacticasl missions on the ground. It is the desire to develop a viable cost-effective overall system design for accomplishing this goal. For example, future Unmanned Air Vehicle (UAV) concepts in concert with autonomous guidance and control operational scenarios significantly increase the regional functionality, while opening the design trade (performance specifications) space compared to existing military systems. The complexity of future NANO UAV's control systems require that control system design engineers must, at the onset of the design process, be aware of the essential aspects involved in achieving a successful and a practical control system design and be aware of the associated computer computational requirements.. That is: factors such as functional requirements, performance specifications, dynamic model(s), control authority allocation, control system design, simulations, engineering visualization, interactive simulation, hardware-in-the-loop simulation/implementation, and system test. This lecture series is an excellent forum to present state-of-the-art system, design method, and the computational concepts on some or all of these factors.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**	USAR	3	**19b. TELEPHONE NUMBER** *(include area code)*
UU	UU	U			